Grundfos CIU 300

BACnet MS/TP for Grundfos Hydro MPC, Control MPC and Multi-E

GB Functional profile and user manual

Original installation and operating instructions.

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1. Symbol used in this document

Note *Notes or instructions that make the job easier and ensure safe operation.*

2. Introduction

2.1 About this functional profile

This functional profile describes the CIU 300 (BACnet Communication Interface Unit 300) for the following Grundfos booster systems:

- Grundfos Hydro MPC (CU 351)
- Grundfos Control MPC (CU 351)
- Grundfos Hydro Multi-E.

The object lists for Hydro MPC and Control MPC are identical, so in the following, only Hydro MPC is mentioned. If not specifically mentioned, Hydro MPC and Hydro Multi-E are referred to as "booster".

The data in this document are subject to change without prior notice. Grundfos cannot be held responsible for any problems caused directly or indirectly by using information in this functional profile.

2.2 Assumptions

This functional profile assumes that the reader is familiar with commissioning and programming BACnet devices. The reader should have some basic knowledge of the BACnet protocol and technical specifications. It is also assumed that an existing BACnet MS/TP network is present.

2.3 Definitions and abbreviations

CIM	Communication Interface Module, a Grundfos add-on module
CIU	Communication Interface Unit, a Grundfos box for CIM modules
CRC	Cyclic Redundancy Check, a data error detection method
CU 351	Grundfos Control Unit 351
Device	A node on the BACnet MS/TP network
GENIbus	Proprietary Grundfos fieldbus standard based on RS-485
Inter-network	A set of two or more BACnet networks interconnected by routers
LED	Light Emitting Diode
MAC	Media Access Control, a sublayer of the data communication protocol
MPC	Multi-Pump Controller
MS/TP	Master-Slave / Token-Passing, a data protocol used for BACnet RS-485
Router	A device that connects two or more networks at the network layer
Transmission speed	Bits transferred per second
Trunk cable	Main RS-485 cable on a BACnet MS/TP network

2.4 System diagram

The system diagram gives an overview of how to connect the CIM/CIU 300 to the Grundfos booster system that is to be connected to a BACnet MS/TP network.

The CIU 300 solution is a box with a power supply module and a CIM 300 BACnet module. It can either be mounted on a DIN rail or on a wall.
It is used in conjunction with Grundfos Hydro MPC, Control MPC and Multi-E.

Note ***The CU 351 must have an external GENIbus module installed to communicate with the CIU 300 BACnet unit.***

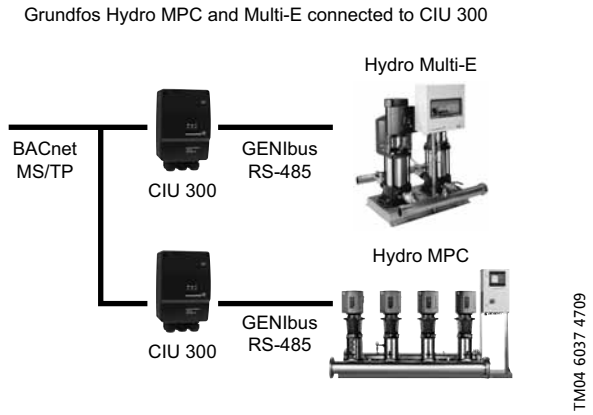

Fig. 1 CIU 300 solution for Hydro MPC and Hydro Multi-E

2.5 Specifications

General data	Description	Comments
GENIbus visual diagnostics	LED2	Red/green status LED. See section *4.2 LED2, internal communication*.
Communication Interface Unit (CIU 300)		
Power supply	24-240 V AC/DC	Located in the CIU 300.
GENIbus connection type	RS-485	
GENIbus wire configuration	Three-wire + screen	Conductors: A, B and Y.
BACnet		
Data protocol	BACnet MS/TP	
BACnet connector	Screw-type terminal	3 pins. See section *3.2 CIM 300 BACnet module*.
BACnet connection type	RS-485	
BACnet wire configuration	Two-wire + ground	Conductors: Plus, Minus and Ground. See section *3.3 Connecting to the BACnet network*.
Maximum cable length [m]	1200	Equals 4000 ft
MAC address	0-127	Set via rotary switches SW6 and SW7. See section *3.7 Selecting the BACnet MAC address*.
Line termination	On or Off	Set via DIP switches SW1 and SW2. See section *3.8 Termination resistor*.
Supported transmission speeds [bits/s]	9600, 19200, 38400, 76800	Set via DIP switches SW4 and SW5. See section *3.4 Setting the BACnet transmission speed*.
Data bits	8	Fixed value.
Stop bits	1	Fixed value.
Parity	None	Fixed value.
BACnet visual diagnostics	LED1	Red/green status LED. See section *4.1 LED1, BACnet MS/TP communication*.
Maximum number of BACnet devices	32	Using repeaters, this number can be increased.
Grundfos BACnet vendor ID	227	
BACnet segmentation support	No	
Character set support	ANSI X3.4	Base definition for the widely used character code known as ASCII.
BACnet device profile	B-ASC	BACnet Application-Specific Controller.
BACnet MS/TP master	Yes	The CIM/CIU 300 is a BACnet MS/TP master device.
Manual slave address binding	No	

3. BACnet interface

3.1 BACnet bus topology

The Grundfos CIM/CIU 300 is connected as a BACnet MS/TP master directly to the BACnet MS/TP network.

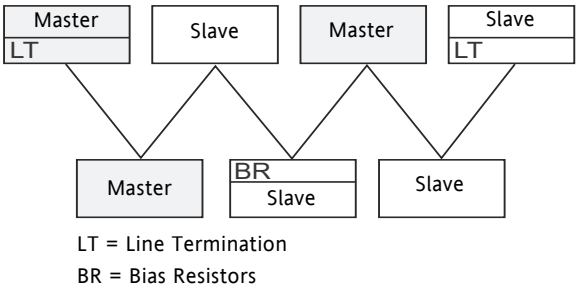

Fig. 2 Example of BACnet MS/TP network

BACnet MS/TP is a multi-master system, meaning that there can be more than one master on the network. It uses a token to control access to the bus network. A master node may initiate the transmission of a data telegram when it holds the token. Both master and slave nodes may transmit data telegrams in response to requests from master nodes, but slaves never hold the token. Master nodes pass the token between them.

A BACnet MS/TP segment is a single contiguous medium to which BACnet nodes are attached. Segments can be connected by use of repeaters or bridges, thus forming networks.

Multiple networks may be interconnected by BACnet routers to form a BACnet inter-network.

3.1.1 Line termination resistors

Line termination must be connected at each of the two ends of the segment medium. The CIM/CIU 300 has optional line termination resistor on board.

3.1.2 Bias resistors

At least one set, and no more than two sets, of network bias resistors must exist for each segment so that an undriven communications line will be held in a guaranteed logical one state. The bias provides a reliable way for stations to detect the presence or absence of signals on the line. An unbiased line will take an indeterminate state in the absence of any driving node.

The CIM/CIU 300 has no bias resistors.

3.2 CIM 300 BACnet module

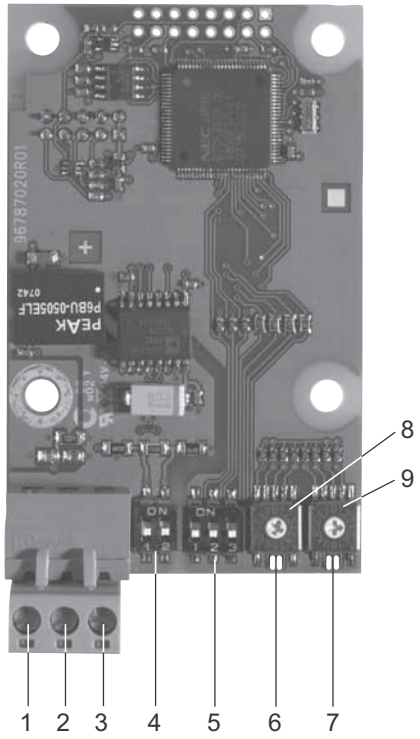

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Fig. 3 CIM 300 BACnet module

Pos.	Designation	Description
1	Plus	BACnet Plus terminal (RS-485 positive data signal)
2	Minus	BACnet Minus terminal (RS-485 negative data signal)
3	Ground	BACnet Ground terminal
4	SW1/SW2	On/off switches for termination resistor
5	SW3/SW4/SW5	Switches for selecting the BACnet transmission speed and the default or custom Device Object Instance Number
6	LED1	Red/green status LED for BACnet communication
7	LED2	Red/green status LED for internal communication between the CIM 300 and the Grundfos booster
8	SW6	Hexadecimal rotary switch for setting the BACnet MAC address (four most significant bits)
9	SW7	Hexadecimal rotary switch for setting the BACnet MAC address (four least significant bits)

3.3 Connecting to the BACnet network

A screened, twisted-pair cable must be used.

BACnet terminal	Recommended colour	Data signal
Plus	Red	Positive
Minus	Green	Negative
Ground	Grey	Ground

The ANSI/ASHRAE BACnet standard states that the cable screen must only be earthed at one end of the segment to prevent earth fault currents.

3.4 Setting the BACnet transmission speed

The transmission speed must be set correctly before the CIM 300 is ready to communicate on the BACnet MS/TP network. DIP switches SW4 and SW5 are used to set the transmission speed.
The default transmission speed is 9600 bits/s, but higher speeds are recommended for better data throughput. All devices on the BACnet MS/TP network must communicate at the same transmission speed.

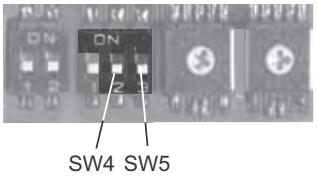

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Fig. 4 BACnet transmission speed settings

3.4.1 DIP switch settings

Available transmission speeds in bits/s: 9600, 19200, 38400 and 76800.

Use DIP switches SW4 and SW5 to select the desired speed.

Transmission speed [bits/s]	SW4	SW5
9600	OFF	OFF
19200	OFF	ON
38400	ON	OFF
76800	ON	ON

The default transmission speed is 9600 bit/s, as per the BACnet MS/TP standard. The transmission speed will be effective immediately after setting the values of the DIP switch.

3.5 Selecting the Device Object Instance Number

The Device Object Identifier value consists of two components:

- a 10-bit Object Type (bits 22 to 31)
- a 22-bit Instance Number (bits 0 to 21).

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Fig. 5 Bit numbers

The Object Type is fixed and determines that it is a Device Object. The Instance Number is a numeric code that is used to identify the device. It must be unique inter-network-wide, i.e. on all interconnected networks.

The CIM 300 offers two different approaches to setting the BACnet Device Object Instance Number: default and custom, both described in the following subsections.

3.5.1 Default Instance Number

By default, the CIM 300 uses a pre-defined Device Object Instance Number, which is 227XXX where XXX is the BACnet MAC address. This gives an Instance Number range of 227000 to 227127.
See section *3.7 Selecting the BACnet MAC address* for more information on MAC addresses.

Example:

The BACnet MAC address is set to 20 via the hexadecimal rotary switches, so the Device Object Instance Number is 227020.

3.5.2 Custom Instance Number

To use the complete Instance Number range, set the new Instance Number with the BACnet object Custom Device Object Instance Number (AV, 0), and set SW3 to ON. This will immediately set the new Device Object Instance Number.
See fig. 6 for DIP switch location.

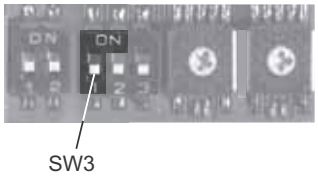

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Fig. 6 Device Object Instance Number

Device Object Instance Number	SW3
Default (227000 + BACnet MAC address)	OFF
Custom, set with object (AV, 0)	ON

The default Present_Value of the Custom Device Object Instance Number is 231.

Example:

The Present_Value of Custom Device Object Instance Number (AV, 0) is 231, so the Device Object Instance Number is 231.

Note

The Present_Value of Custom Device Object Instance Number cannot be 4194303, as this is a reserved value.

3.6 Selecting the Device Object Name

The property Device_Name is a character string that must be unique inter-network-wide. By default, the name will be constructed as "Grundfos - XXXXXX" where XXXXXX is the current Device Object Instance Number as described in section *3.5 Selecting the Device Object Instance Number*.

Example:

The Device Object Instance Number is 227001, so the Device Object Name is "Grundfos - 227001".

If a new name is selected, it will be stored in the device and replace the default naming scheme.

3.7 Selecting the BACnet MAC address

To set the BACnet MAC address, use the two hexadecimal rotary switches (SW6 and SW7).

The value must be within the range of 0 to 127. An illegal value will result in a MAC address of 0.

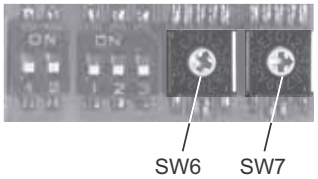

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Fig. 7 Setting the BACnet MAC address

For a complete overview of BACnet addresses, see section *12. BACnet MAC address*.

Note

The BACnet MAC address must be set decimally from 0 to 127 and must be unique on the BACnet MS/TP segment.

3.8 Termination resistor

A termination resistor for line termination is fitted on the CIM 300 and has a value of 120 Ω. It should be cut in if the CIM 300 is set as the last station on the network.

The CIM 300 has two DIP switches (SW1 and SW2) for cutting the termination resistor in and out. Figure 8 shows the DIP switches in cut-out state.

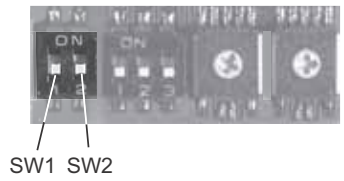

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Fig. 8 Cutting the termination resistor in and out

Status	SW1	SW2
Cut-in	ON	ON
Cut-out	OFF	OFF
	ON	OFF
	OFF	ON

Default setting: Termination resistor cut-out.

3.9 Cable length

The maximum recommended cable length within a BACnet MS/TP segment is 1200 metres (4000 ft) with 0.82 mm^2 (AWG 18) cable.

The connection between the BACnet modules must be made by use of a screened, twisted-pair cable with a characteristic impedance between 100 and 130 Ω.

4. LEDs

The CIM 300 BACnet module has two LEDs.

- Red/green status LED (LED1) for BACnet MS/TP communication
- Red/green status LED (LED2) for internal communication between the CIM 300 and the Grundfos booster.

4.1 LED1, BACnet MS/TP communication

Status	Description
Off	No communication.
Flashing green	Communication active.
Flashing red	Fault in the BACnet communication.
Permanently red	Fault in the CIM 300 BACnet configuration.

4.2 LED2, internal communication

Status	Description
Off	The CIM 300 has been switched off or is starting up
Flashing red	No internal communication between the CIM 300 and the booster.
Permanently red	The CIM 300 does not support the specific booster version.
Permanently green	Internal communication between the CIM 300 and the booster is OK.

Note *During start-up, there may be a delay of up to 5 seconds before the LED status is updated.*

5. Supported services

BACnet Interoperability Building Blocks (BIBBs) are collections of one or more BACnet services. These are described in terms of an "A" and a "B" device. Both devices are nodes on a BACnet inter-network. In most cases, the "A" device will act as the user of data (client), and the "B" device will be the provider of this data (server).

The CIM/CIU 300 is a BACnet Application-Specific Controller (B-ASC) with a few additional services.

5.1 Data sharing services

Name	BACnet BIBB code	Notes	Initiate	Execute
ReadProperty	DS-RP-B	The CIM/CIU 300 can be a provider of data.		X
ReadPropertyMultiple	DS-RPM-B	The CIM/CIU 300 can be a provider of data and return multiple values at one time.		X
WriteProperty	DS-WP-B	The CIM/CIU 300 allows a value to be changed over the network.		X
WritePropertyMultiple	DS-WPM-B	The CIM/CIU 300 allows multiple values to be changed over the network.		X
SubscribeCOV	DS-COV-B	The CIM/CIU 300 can be a provider of "Change Of Value" data. It supports up to 10 simultaneous COV subscriptions. Subscription lifetime can be limited or unlimited.		X
ConfirmedCOVNotification			X	
UnconfirmedCOVNotification			X	

5.2 Device management services

Name	BACnet BIBB code	Notes	Initiate	Execute
Who-Is	DM-DDB-A	The CIM/CIU 300 can seek information about device attributes of other devices and interpret device announcements.	X	
I-Am				X
Who-Is	DM-DDB-B	The CIM/CIU 300 can provide information about its device attributes and responds to requests to identify itself.		X
I-Am			X	
Who-Has	DM-DOB-B	The CIM/CIU 300 can provide address information about its objects upon request.		X
I-Have			X	
DeviceCommunicationControl	DM-DCC-B	The CIM/CIU 300 can respond to communication control requests. It supports both limited and unlimited duration.		X

6. Object overview

6.1 Device Object

The following properties are supported in the Device Object (available for all booster types).

Property identifier	Data type	Notes	Access
Object_Identifier	BACnetObjectIdentifier	See section *3.5 Selecting the Device Object Instance Number*.	R
Object_Name	CharacterString	See section *3.6 Selecting the Device Object Name*.	W
Object_Type	BACnetObjectType	DEVICE.	R
System_Status	BACnetDeviceStatus	OPERATIONAL.	R
Vendor_Name	CharacterString	Grundfos.	R
Vendor_Identifier	Unsigned16	227.	R
Model_Name	CharacterString	Will show the Grundfos booster model to which the CIM/CIU 300 is connected.	R
Firmware_Revision	CharacterString	Revision of the firmware in the CIM/CIU 300.	R
Application_Software_Version	CharacterString	Software build date, DD-MM-YYYY.	R
Location	CharacterString	The user can enter a location here (maximum 200 characters).	W
Description	CharacterString	The user can enter a description here (maximum 200 characters).	W
Protocol_Version	Unsigned	Actual version of the BACnet protocol.	R
Protocol_Revision	Unsigned	Actual revision of the BACnet protocol.	R
Protocol_Services_Supported	BACnetServicesSupported	Indicates which standardised protocol services are supported.	R
Protocol_Object_Types_Supported	BACnetObjectTypesSupported	Indicates which standardised protocol object types are supported.	R
Object_List	BACnetARRAY[N]of BACnetObjectIdentifier	An array of objects available.	R
Max_APDU_Length_Accepted	Unsigned	The maximum number of bytes that may be contained in a single APDU. Fixed to 480.	R
Segmentation_Supported	BACnetSegmentation	Indicates if segmentation of messages is possible. Will always read NO_SEGMENTATION.	R
APDU_Timeout	Unsigned	Indicates the amount of time in ms before timeout.	R
Number_Of_APDU_Retries	Unsigned	Maximum number of times an APDU is to be retransmitted.	R
Max_Master	Unsigned	Specifies the highest possible MAC address for master nodes and must be between 1 and 127. The default value is 127, but this value can be lowered by the user. The Max_Master value must be higher than or equal to the highest MAC address used by a master node in an MS/TP network.	W
Max_Info_Frames	Unsigned	Specifies the maximum number of information frames that are sent before the token is passed on. Fixed to 1.	R
Device_Address_Binding	List of BACnetAddress-Bindings	Holds address bindings to other devices, if any.	R
Database_Revision	Unsigned	Logical revision number for the device database.	R

6.2 Binary inputs

Binary objects that provide information from the Grundfos booster.

ID	Object Name	R/W	Notes	Multi-E	MPC
BI, 0	Control source status	R	Status of the actual control source. 0 = Local control 1 = Bus control.	X	X
BI, 2	Rotation status	R	Rotation status. 0 = No rotation 1 = Rotation (one or more pumps running).	X	X
BI, 3	At minimum speed	R	0 = Not running at minimum speed 1 = Running at minimum speed.	X	X
BI, 4	At maximum speed	R	0 = Not running at maximum speed 1 = Running at maximum speed.	X	X
BI, 5	Standby pumps active	R	0 = Standby pumps not active 1 = Standby pumps active.		X
BI, 6	Pressure relief active	R	0 = Pressure relief not active 1 = Pressure relief active.		X
BI, 7	Soft pressure active	R	0 = Soft pressure not active 1 = Soft pressure active.		X
BI, 8	Low flow boost active	R	0 = Low flow boost not active 1 = Low flow boost active.		X
BI, 9	Low flow stop active	R	0 = Low flow stop not active 1 = Low flow stop active.		X
BI, 10	Alternative setpoint active	R	0 = Alternative setpoint not active 1 = Alternative setpoint active.		X
BI, 11	Digital input 1 status	R	0 = Not active 1 = Active.	X	X
BI, 12	Digital input 2 status	R	0 = Not active 1 = Active.	X	X
BI, 13	Digital input 3 status	R	0 = Not active 1 = Active.	X	X
BI, 14	Digital output 1 status	R	0 = Not active 1 = Active.	X	X
BI, 15	Digital output 2 status	R	0 = Not active 1 = Active.	X	X
BI, 16	Subpump 1 presence	R	0 = Subpump not present 1 = Subpump present.	X	X
BI, 17	Subpump 1 communication status	R	0 = Communication OK 1 = Communication fault.	X	X
BI, 18	Subpump 2 presence	R	0 = Subpump not present 1 = Subpump present.	X	X
BI, 19	Subpump 2 communication status	R	0 = Communication OK 1 = Communication fault.	X	X
BI, 20	Subpump 3 presence	R	0 = Subpump not present 1 = Subpump present.	X	X
BI, 21	Subpump 3 communication status	R	0 = Communication OK 1 = Communication fault.	X	X
BI, 22	Subpump 4 presence	R	0 = Subpump not present 1 = Subpump present.	X	X
BI, 23	Subpump 4 communication status	R	0 = Communication OK 1 = Communication fault.	X	X
BI, 24	Subpump 5 presence	R	0 = Subpump not present 1 = Subpump present.	X	X
BI, 25	Subpump 5 communication status	R	0 = Communication OK 1 = Communication fault.	X	X
BI, 26	Subpump 6 presence	R	0 = Subpump not present 1 = Subpump present.	X	X
BI, 27	Subpump 6 communication status	R	0 = Communication OK 1 = Communication fault.	X	X
BI, 28	Fault simulation status	R	Fault simulation status. 0 = Fault simulation disabled 1 = Fault simulation enabled.		X

6.3 Binary outputs

Binary objects for control of the Grundfos booster.

ID	Object Name	R/W	Notes	Multi-E	MPC
BO, 0	Set control source	W	Sets the control source. Set to 1 to enable control via BACnet. 0 = Local control (default) 1 = Bus control.	X	X
BO, 4	Reset fault	W	Resets alarm if bus control is enabled. (Triggered on rising edge). 0 = No resetting (default) 1 = Resetting.	X	X
BO, 5	Fault simulation	W	Enables fault simulation. 0 = Disabled (default) 1 = Enabled.		X

6.4 Multistate inputs

Objects that contain an enumeration value from the booster.

ID	Object Name	R/W	Notes	Multi-E	MPC
MI, 0	Actual control mode	R	Reads the current control mode. 1 = Constant speed 2 = Constant pressure 3 = Proportional pressure 4 = RESERVED 5 = Constant flow 6 = Constant temperature 7 = Constant level 8 = Constant percentage. See section *7.1 Control modes* for details on the control modes.	X	X
MI, 1	Actual operating mode	R	Reads the current operating mode. 1 = Start (normal) 2 = Stop 3 = Minimum 4 = Maximum.	X	X
MI, 3	CIM status	R	Reads the status of the CIM module, useful for fault finding. 1 = OK 2 = EEPROM fault 3 = Memory fault.	X	X
MI, 4	Subpump 1 control source	R	1 = Buttons 2 = GENIbus 3 = GENIlink 4 = External control.		X
MI, 5	Subpump 2 control source	R	1 = Buttons 2 = GENIbus 3 = GENIlink 4 = External control.		X
MI, 6	Subpump 3 control source	R	1 = Buttons 2 = GENIbus 3 = GENIlink 4 = External control.		X
MI, 7	Subpump 4 control source	R	1 = Buttons 2 = GENIbus 3 = GENIlink 4 = External control.		X
MI, 8	Subpump 5 control source	R	1 = Buttons 2 = GENIbus 3 = GENIlink 4 = External control.		X
MI, 9	Subpump 6 control source	R	1 = Buttons 2 = GENIbus 3 = GENIlink 4 = External control.		X

6.5 Multistate outputs

Objects that set an enumeration value in the booster.

ID	Object Name	R/W	Notes	Multi-E	MPC
MO, 0	Set control mode	W	Sets the control mode if bus control is enabled. 1 = Constant speed 2 = Constant pressure 3 = Proportional pressure 4 = RESERVED 5 = Constant flow 6 = Constant temperature 7 = Constant level 8 = Constant percentage. See section *7.1 Control modes* for details on the control modes. Note: Multi-E always runs constant pressure mode.		X
MO, 1	Set operating mode	W	Sets the operating mode if bus control is enabled. 1 = Start (normal) 2 = Stop 3 = Minimum (MPC only) 4 = Maximum.	X	X
MO, 2	Product simulation	W	Enables product simulation (for commissioning and testing purposes, can only be enabled when no physical booster is present). 1 = Disabled 5 = Hydro Multi-E 6 = Hydro MPC. See section *7.7 Product simulation* for details.	X	X

6.6 Analog inputs

Objects with measured values and status information from the booster.

ID	Object Name	R/W	Notes	Unit	Multi-E	MPC
AI, 0	Fault code	R	Grundfos fault code. See section *11. Grundfos alarm and warning codes*.	-	X	X
AI, 1	Warning code	R	Grundfos warning code. See section *11. Grundfos alarm and warning codes*.	-	X	X
AI, 3	Capacity	R	Actual capacity value (process feedback).	%	X	X
AI, 4	Head	R	Actual system head/pressure.	bar	S	S
AI, 5	Flow	R	Actual system flow.	m^3/h	S	S
AI, 6	Relative performance	R	Performance relative to maximum performance.	%	X	X
AI, 9	Actual setpoint	R	Actual setpoint.	%	X	X
AI, 10	Motor current	R	Actual motor current.	A	X	
AI, 13	Power	R	Total power consumption of the system.	W	X	X
AI, 15	Inlet pressure	R	System inlet pressure.	bar		S
AI, 16	Remote pressure	R	Measured pressure at external sensor.	bar		S
AI, 17	Level	R	Tank level.	m	S	S
AI, 20	Remote temperature	R	Temperature at external sensor.	°C	S	S
AI, 25	Auxiliary sensor input	R	Auxiliary sensor input.	%	S	
AI, 27	Runtime	R	Total operating time of the system.	h	X	X
AI, 30	Energy consumption	R	Total energy consumption of the system.	kWh	X	X
AI, 33	Ambient temperature	R	Ambient temperature.	°C		S
AI, 34	Forward temperature	R	Flow-pipe temperature.	°C		S
AI, 35	Return temperature	R	Return-pipe temperature.	°C		S
AI, 36	Differential temperature	R	Differential temperature.	°C		S
AI, 37	Outlet pressure	R	System outlet pressure.	bar		S
AI, 38	Feed tank level	R	Actual level in the feed tank.	m		S
AI, 39	Subpump 1 fault code	R	Fault code of subpump 1.	-	X	X
AI, 40	Subpump 1 runtime	R	Total operating time of subpump 1.	h	X	X
AI, 41	Subpump 1 speed	R	Actual speed of subpump 1.	%		X
AI, 42	Subpump 2 fault code	R	Fault code of subpump 2.	-	X	X
AI, 43	Subpump 2 runtime	R	Total operating time of subpump 2.	h	X	X
AI, 44	Subpump 2 speed	R	Actual speed of subpump 2.	%		X
AI, 45	Subpump 3 fault code	R	Fault code of subpump 3.	-	X	X
AI, 46	Subpump 3 runtime	R	Total operating time of subpump 3.	h	X	X
AI, 47	Subpump 3 speed	R	Actual speed of subpump 3.	%		X
AI, 48	Subpump 4 fault code	R	Fault code of subpump 4.	-	X	X
AI, 49	Subpump 4 runtime	R	Total operating time of subpump 4.	h	X	X
AI, 50	Subpump 4 speed	R	Actual speed of subpump 4.	%		X
AI, 51	Subpump 5 fault code	R	Fault code of subpump 5.	-	X	X
AI, 52	Subpump 5 runtime	R	Total operating time of subpump 5.	h	X	X
AI, 53	Subpump 5 speed	R	Actual speed of subpump 5.	%		X
AI, 54	Subpump 6 fault code	R	Fault code of subpump 6.	-	X	X
AI, 55	Subpump 6 runtime	R	Total operating time of subpump 6.	h	X	X
AI, 56	Subpump 6 speed	R	Actual speed of subpump 6.	%		X

X = Always available.

S = Sensor required.

6.7 Analog outputs

Object for setting a new setpoint in the booster.

ID	Object Name	R/W	Notes	Unit	Multi-E	MPC
AO, 0	Set setpoint	W	Sets the booster setpoint if bus control is enabled. A value of 0 does not imply a stop. See section *7.2 Setpoint.*.	%	X	X

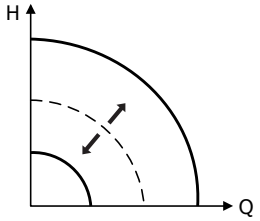
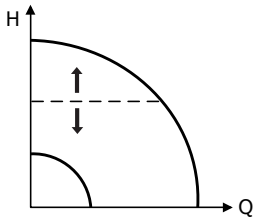
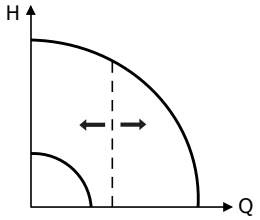
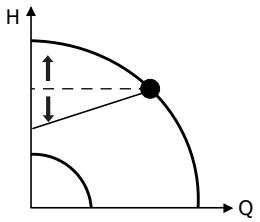
6.8 Analog values

Objects for configuration of the CIM/CIU 300 and/or the booster.

ID	Object Name	R/W	Notes	Multi-E	MPC
AV, 0	Custom device object instance number	R/W	Value for Custom Device Object Instance Number. Used in conjunction with DIP switch SW3. See section *3.5 Selecting the Device Object Instance Number*. Present_Value range: 0-0x3FFFFE. Default Present_Value: 0xE7.	X	X
AV, 1	BACnet watchdog	R/W	Time in seconds before BACnet communication watchdog times out, and sets the booster to use its local settings. See section *7.3 BACnet communication watchdog*. 0 = Disabled (default) Set to a value between 5 and 3600 to enable.	X	X
AV, 4	Simulation event code	R/W	Event code to simulate. The following event code values are available for simulation (among others): 000 = No alarm 003 = External fault 010 = Pump communication alarm 089 = Closed-loop feedback sensor signal fault 088 = General (meas.) sensor signal fault 203 = All pumps in alarm 210 = Pressure high 211 = Pressure low 214 = Water shortage 231 = No Ethernet address from DHCP server.		X
AV, 5	Simulation device type	R/W	Device type of simulated event. 0 = Controller 2 = Pump 3 = IO 351 4 = Primary sensor 7 = IO 351 8 = System 9 = Analog input 10 = Pilot pump 11 = Limit-exceeded function.		X
AV, 6	Simulation device number	R/W	Device number of simulated event. If the device type is "Pump", the device number indicates the pump number [1-6]. If the device type is "Analog input", the device number indicates the sensor that generated the event [1-7].		X
AV, 7	Simulation event action type	R/W	The associated action to the event. 0 = Go to operating mode "Stop". 1 = Go to operating mode "Stop" (delay). 2 = Go to operating mode "Minimum". 3 = Go to operating mode "User-defined". 4 = Go to operating mode "Maximum". 5 = Set pumps in source mode to "Local control". 6 = No action (warning only). 7 = Go to operating mode "Emergency run".		X
AV, 8	Simulation event reset type	R/W	Resetting type for simulated event. Manual or automatic. 0 = Manual resetting 1 = Automatic resetting.		X

7. Detailed descriptions

7.1 Control modes

Control modes	Description	Illustration
Constant speed	**Open loop** The setpoint of the booster system will be interpreted as setpoint for the system performance. The setpoint value is a percentage of the maximum performance of the subpumps. No sensor is required.	
Constant pressure	**Closed loop** The setpoint of the booster system will be interpreted as setpoint for the pressure. The controller in the booster system will change the booster speed so that the pressure is constant, regardless of the flow. A pressure sensor is required.	
Constant flow Constant level Constant temperature Constant percentage	**Closed loop** Constant flow, constant level, constant temperature or constant percentage can be obtained by replacing the main pressure sensor with another sensor, e.g. a flow sensor is needed for flow control, a level sensor is needed for level control and a temperature sensor is needed for temperature control. Constant flow is illustrated to the right.	
Proportional pressure	**Closed loop** The setpoint of the booster system will be interpreted as basic setpoint for the proportional-pressure mode (the black dot in the illustration). A pressure sensor is required.	

H = Pressure (Head)

Q = Flow

7.2 Setpoint

This object accepts values ranging from 0 to 100 (0 % to 100 %). This is illustrated in fig. 9.

Note ***The setpoint is a percentage of the maximum setpoint or sensor maximum (max. = 100 %).***

The setpoint value can represent speed, pressure, flow, etc., depending on the selected control mode.

A setpoint of 0 does not imply a stop.

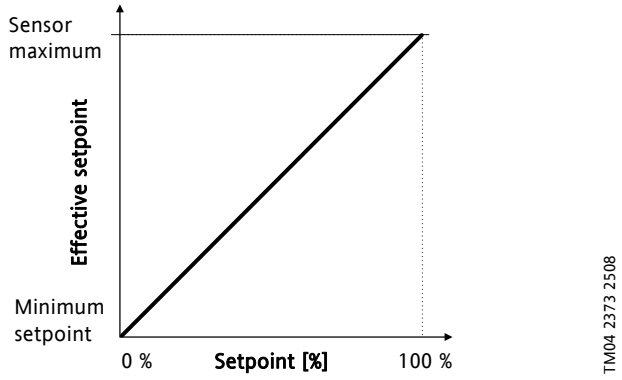


Fig. 9 Setpoint

7.2.1 Setpoint examples

Closed loop

If the control mode is set to Constant pressure (closed loop) and the pressure sensor is in the range of 0 to 10 bar, a setpoint of 80 % will result in an effective setpoint of 8 bar.

If the sensor range was 0 to 16 bar, a 50 % setpoint would be 8 bar, a 25 % setpoint would be 4 bar, and so on.

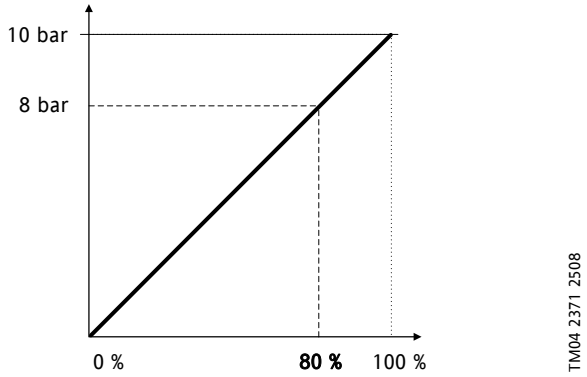


Fig. 10 Constant pressure

Open loop

If the control mode is set to Constant speed (open loop), the setpoint is interpreted as setpoint for the booster performance.

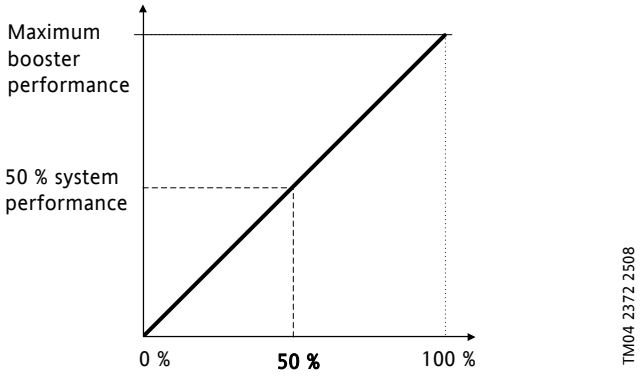


Fig. 11 Constant speed

7.3 BACnet communication watchdog

A BACnet communication watchdog is implemented in the CIM/CIU 300. If no BACnet communication is detected for the time period defined by the BACnet watchdog object (AV, 1), and the control source of the booster is set to Bus control (BO, 0), the CIM 300 will make the booster run with the settings defined in local mode.

This functionality can be used to define the booster behaviour in case of a BACnet communication breakdown. Before enabling the watchdog, the local booster settings should be made with either a Grundfos PC Tool or the Grundfos R100 remote control (for Multi-E only). This ensures that the booster behaves as expected if the BACnet communication breaks down.

When BACnet communication is re-established after a watchdog timeout, the booster will run with the remote settings again.

When the Present_Value of the AV, 1 object is set to 0, the watchdog is disabled (default). To enable the watchdog, set the Present_Value to [5-3600] seconds.

7.4 Fault monitoring and resetting

This example shows how to monitor faults or warnings in the booster and how to manually reset a fault.

The Fault code object (AV, 0) and the Warning code object (AV, 1) can both hold a Grundfos-specific fault code. See section *11. Grundfos alarm and warning codes* for code interpretation.

Warnings are notifications only, and a warning will normally not stop the booster system.

If a fault is to be manually reset, use the Reset fault object (BO, 4). When the Present_Value of this object is set to 1, a Reset fault command is sent to the device.

7.5 Fault simulation example

Fault simulation can be helpful for testing alarm behaviour for a Hydro MPC booster system. The system will behave exactly as if a real alarm was present.

This example shows how to simulate a "Pressure high" alarm on a Hydro MPC that will result in a stop of all pumps, and require manual resetting.

- Set "Simulation event code" (AV, 4) to 210 (Pressure high).
- Set "Simulation device type" (AV, 5) to 8 (System).
- Set "Simulation device number" (AV, 6) to 1 (System).
- Set "Simulation event action type" (AV, 7) to 0 (Stop).
- Set "Simulation event reset type" (AV, 8) to 0 (Manual resetting).
- Set "Fault simulation" (BO, 5) to 1 (Enabled).
- The CU 351 will now enter into the system mode "Event action", and in this case stop all pumps, and the red LED on the CU 351 will be on. On the CU 351 display, the "Pressure high" alarm is indicated.
- Read "Fault simulation status" (BI, 28), and see that it is set to 1 (Fault simulation enabled).
- Remove the simulated alarm settings by setting "Fault simulation" (BO, 5) to 0 (Disabled).
- Reset the alarm via the CU 351 display or via the BACnet object "Reset fault" (BO, 4), and the CU 351 will go back to normal operation.

7.6 Control via BACnet

This example shows how to set a Hydro MPC to 50 % setpoint, constant-pressure mode and bus control.

Before enabling control via BACnet, values for setpoint, control mode and operating mode should be set.

- Enable bus control via the CU 351 display (settings/secondary functions/control source, and select "controlled from bus").
- Set operating mode with Multistate output 1 (MO, 1). In this example, the value for operating mode should be 1 (Start).
- Set control mode with Multistate output 0 (MO, 0). A value of 2 corresponds to Constant pressure.
- Set the setpoint to a value of 50 with Analog output 0 (AO, 0). See section *7.2 Setpoint* for details on setpoint.
- To enable bus control via BACnet, set the Binary output 0 (BO, 0) to a value of 1.

Now the Hydro MPC should be running at 50 % in constant-pressure mode with bus control.

7.7 Product simulation

Product profile simulation (booster simulation) can be useful for testing and pre-commissioning purposes. It is possible to simulate a booster profile when using a CIU 300 that is not connected to any product. The CIU 300 will behave as if a booster was connected on the GENIbus, even if that is not the case. The objects supported by the simulated product will be available, although the data will only be dummy values that do not simulate real booster behaviour.

Product simulation is enabled by setting the Multistate output object "Product simulation" (MO, 2):

Product to simulate	Value
Disabled (no simulation)	1
Multi-E	5
Hydro MPC (CU 351)	6

Note *Product simulation will always be disabled on power-up.*

Note *If a physical booster is detected on GENIbus at power-up, it will not be possible to enable product simulation.*

8. Commissioning

8.1 Step-by-step guide to hardware setup (CIU 300)

Step	Action
1	Complete the booster configuration, e.g. sensor configuration.
2	Select the BACnet MAC address (0-127) on the CIM 300. See section *3.7 Selecting the BACnet MAC address*.
3	Select the transmission speed of the CIM 300. See section *3.4 Setting the BACnet transmission speed*.
4	Select Device Object Instance Number. See section *3.5 Selecting the Device Object Instance Number*.
5	If necessary, set line termination. See section *3.8 Termination resistor*.
6	Connect the GENIbus cable from the CIU 300 to the booster.
7	Connect the necessary cables from the CIU 300 to the BACnet network. See section *3.3 Connecting to the BACnet network*.
8	Connect the power supply cable to the CIU 300, and switch it on.
9	Confirm that the GENIbus LED is constantly green and that the BACnet LED is either off or flashing green (indicating communication). See section *4. LEDs*.
The CIU 300 is now configured and ready.	

9. Fault finding

9.1 LED status

Faults in a CIM/CIU 300 can be detected by observing the status of the two communication LEDs. See the table below.

Fault (LED status)	Possible cause	Remedy
1. Both LEDs (LED1 and LED2) remain off when the power supply is connected, and 5 seconds have passed.	a) The CIM 300 is defective.	Replace the CIM 300.
2. The LED for internal communication (LED2) is flashing red.	a) No internal communication between the CIM/CIU 300 and the Grundfos booster.	• Check the cable connection between the booster and the CIU 300. • Check that the individual conductors have been fitted correctly. • Check the power supply to the booster.
3. The LED for internal communication (LED2) is constantly red.	a) The CIU 300 does not support the connected booster.	Contact the nearest Grundfos company.
4. The BACnet LED (LED1) is constantly red.	a) Fault in the CIM 300 BACnet configuration.	• Ensure that the BACnet MAC address has a valid setting. See section *3.7 Selecting the BACnet MAC address*. • Ensure that the Device Object Instance Number is within the allowed range. See section *3.5 Selecting the Device Object Instance Number*.
5. The BACnet LED (LED1) is flashing red.	a) Fault in the BACnet communication (cyclic redundancy check).	• Check the transmission speed (switches SW4 and SW5). See section *3.4 Setting the BACnet transmission speed*. • Check the cable connection between the CIM 300 and the BACnet network. • Check the termination resistor settings (switches SW1 and SW2). See section *3.8 Termination resistor*.

9.2 BACnet faults

Fault	Possible cause	Remedy
1. The CIM/CIU 300 does not communicate on the BACnet MS/TP network.	a) Configuration or wiring fault.	Ensure that the cable between the BACnet MS/TP devices is connected correctly. See section *3.3 Connecting to the BACnet network*.
		Ensure that the BACnet MAC address and Device Object Instance Number are configured correctly and are unique on the network. See section *3.7 Selecting the BACnet MAC address* and *3.5 Selecting the Device Object Instance Number* for address selection.
		Ensure that the transmission speed is configured correctly. See section *3.4 Setting the BACnet transmission speed*.
		Ensure that each end of the BACnet MS/TP trunk cable is terminated, if necessary. See section *3.8 Termination resistor* for line termination of the Grundfos CIM/CIU 300.
		Ensure that the bus topology for a BACnet MS/TP network is correct.
	b) The CIM/CIU 300 is instructed to not communicate on the BACnet network via the DeviceCommunicationControl service.	Use the Device Communication Control service to enable communication from the device.
2. The booster does not react to control commands from the bus.	a) The booster is running in local mode.	• Set the booster to bus control by setting the Present_Value of BO, 0 to 1. • Set bus control on the CU 351display (settings/ secondary functions/control source, and select "controlled from bus").
3. There are only a few BACnet objects available, and the GENIbus LED flashes red.	a) There is no communication between the CIM 300 and the booster.	Ensure that the GENIbus cable between the CIM 300 and the booster is connected correctly. Ensure that the booster is switched on and able to communicate on GENIbus.

10. BACnet telegrams

10.1 BACnet MS/TP telegram overview

All BACnet MS/TP telegrams have the following format:

Preamble	Telegram type	Destination	Source	Length	Header CRC	Data	Data CRC	(Pad)
2 bytes: 0x55 0xFF	1 byte	1 byte	1 byte	2 bytes, MSB first	1 byte	Variable, [0-501] bytes	2 bytes, LSB first	At most 1 byte 0xFF

For BACnet MS/TP, the destination address and source address are MAC addresses. See section *3.7 Selecting the BACnet MAC address*.
A destination address of 255 (0xFF) denotes broadcast.

The Length field specifies the length in bytes of the data field which must be between 0 and 501 bytes long.

10.2 Telegram types

The available telegram types are listed below.

Type	Name	Description
00	Token	Used to pass network mastership to the destination device.
01	Poll for master	Discovers the presence of other master devices on the network.
02	Reply to poll for master	Used by a master to indicate a wish to enter the token ring.
03	Test request	Used to initiate a loopback test.
04	Test response	A reply to a test request telegram.
05	BACnet data, expecting reply	Used for data transmission where a reply is expected.
06	BACnet data, not expecting reply	Used for data transmission where no reply is expected.
07	Reply postponed	Used by master devices to defer sending a BACnet data reply.

11. Grundfos alarm and warning codes

This is a general Grundfos alarm and warning code list.

Code	Description	Code	Description	Code	Description
1	Leakage current	35	Gas in pump head, deaerating problem	76	Internal communication fault
2	Missing phase	36	Discharge valve leakage	77	Communication fault, twin-head pump
3	External fault signal	37	Suction valve leakage	78	Fault, speed plug
4	Too many restarts	38	Vent valve defective	79	Functional fault, add-on module
5	Regenerative braking	40	Undervoltage	80	Hardware fault, type 2
6	Mains fault	41	Undervoltage transient	81	Verification error, data area (RAM)
7	Too many hardware shutdowns	42	Cut-in fault (dV/dt)	82	Verification error, code area (ROM, FLASH)
8	PWM switching frequency reduced	45	Voltage asymmetry	83	Verification error, FE parameter area (EEPROM)
9	Phase sequence reversal	48	Overload	84	Memory access error
10	Communication fault, pump	49	Overcurrent (i_line, i_dc, i_mo)	85	Verification error, BE parameter area (EEPROM)
11	Water-in-oil fault (motor oil)	50	Motor protection function, general shutdown (mpf)	88	Sensor fault
12	Time for service (general service information)	51	Blocked motor/pump	89	Signal fault, (feedback) sensor 1
13	Moisture alarm, analog	52	Motor slip high	90	Signal fault, speed sensor
14	Electronic DC-link protection activated (ERP)	53	Kipped motor	91	Signal fault, temperature 1 sensor
15	Communication fault, main system (SCADA)	54	Motor protection function, 3 sec. limit	92	Calibration fault, (feedback) sensor
16	Other	55	Motor current protection activated (MCP)	93	Signal fault, sensor 2
17	Performance requirement cannot be met	56	Underload	94	Limit exceeded, sensor 1
18	Commanded alarm standby (trip)	57	Dry running	95	Limit exceeded, sensor 2
19	Diaphragm break (dosing pump)	58	Low flow	96	Setpoint signal outside range
20	Insulation resistance low	59	No flow	97	Signal fault, setpoint input
21	Too many starts per hour	64	Overtemperature	98	Signal fault, input for setpoint influence
22	Moisture switch alarm, digital	65	Motor temperature 1 (t_m or t_mo or t_mo1)	99	Signal fault, input for analog setpoint
23	Smart trim gap alarm	66	Temperature, control electronics (t_e)	104	Software shutdown
24	Vibration	67	Temperature too high, internal frequency converter module (t_m)	105	Electronic rectifier protection activated (ERP)
25	Setup conflict	68	External temperature/ water temperature (t_w)	106	Electronic inverter protection activated (EIP)
26	Load continues even if the motor has been switched off	69	Thermal relay 1 in motor (e.g. Klixon)	110	Skew load, electrical asymmetry
27	External motor protector activated (e.g. MP 204)	70	Thermal relay 2 in motor (e.g. thermistor)	111	Current asymmetry
28	Battery low	71	Motor temperature 2 (Pt100, t_mo2)	112	Cos φ too high
29	Turbine operation (impellers forced backwards)	72	Hardware fault, type 1	113	Cos φ too low
30	Change bearings (specific service information)	73	Hardware shutdown (HSD)	120	Auxiliary winding fault (single-phase motors)
31	Change varistor(s) (specific service information)	74	Internal supply voltage too high	121	Auxiliary winding current too high (single-phase motors)
32	Overvoltage	75	Internal supply voltage too low	122	Auxiliary winding current too low (single-phase motors)

Code	Description	Code	Description	Code	Description
123	Start capacitor, low (single-phase motors)	183	Signal fault, extra temperature sensor	216	Pilot pump alarm
124	Run capacitor, low (single phase motors)	184	Signal fault, general-purpose sensor	217	Alarm, general-purpose sensor high
144	Motor temperature 3 (Pt100, t_mo3)	185	Unknown sensor type	218	Alarm, general-purpose sensor low
145	Bearing temperature high (Pt100), in general or top bearing	186	Signal fault, power meter sensor	219	Pressure relief not adequate
146	Bearing temperature high (Pt100), middle bearing	187	Signal fault, energy meter	220	Fault, motor contactor feedback
147	Bearing temperature high (Pt100), bottom bearing	188	Signal fault, user-defined sensor	221	Fault, mixer contactor feedback
148	Motor bearing temperature high (Pt100) in drive end (DE)	190	Sensor limit 1 exceeded (e.g. alarm level in WW application)	222	Time for service, mixer
149	Motor bearing temperature high (Pt100) in non-drive end (NDE)	191	Sensor limit 2 exceeded (e.g. high level in WW application)	223	Maximum number of mixer starts per hour exceeded
152	Communication fault, add-on module	192	Sensor limit 3 exceeded (e.g. overflow level in WW application)	224	Pump fault (due to auxiliary component or general fault)
153	Fault, analog output	193	Sensor limit 4 exceeded	225	Communication fault, pump module
154	Communication fault, display	194	Sensor limit 5 exceeded	226	Communication fault, I/O module
155	Inrush fault	195	Sensor limit 6 exceeded	227	Combi event
156	Communication fault, internal frequency converter module	196	Operation with reduced efficiency	228	Not used
157	Real-time clock out of order	197	Operation with reduced pressure	229	Not used
158	Hardware circuit measurement fault	198	Operation with increased power consumption	230	Network alarm
159	CIM fault (Communication Interface Module)	199	Process out of range (monitoring/ estimation/calculation/control)	231	Ethernet: No IP address from DHCP server
160	GSM modem, SIM card fault	200	Application alarm	232	Ethernet: Auto-disabled due to misuse
168	Signal fault, pressure sensor	201	External sensor input high	233	Ethernet: IP address conflict
169	Signal fault, flow sensor	202	External sensor input low	236	Pump 1 fault
170	Signal fault, water-in-oil (WIO) sensor	203	Alarm on all pumps	237	Pump 2 fault
171	Signal fault, moisture sensor	204	Inconsistency between sensors	238	Pump 3 fault
172	Signal fault, atmospheric pressure sensor	205	Level float switch sequence inconsistency	239	Pump 4 fault
173	Signal fault, rotor position sensor (Hall sensor)	206	Water shortage, level 1	240	Lubricate bearings (specific service information)
174	Signal fault, rotor origo sensor	207	Water leakage	241	Motor phase failure
175	Signal fault, temperature 2 sensor (t_mo2)	208	Cavitation	242	Automatic motor model recognition failed
176	Signal fault, temperature 3 sensor (t_mo3)	209	Non-return valve fault	243	Motor relay has been forced (manually operated/commanded)
177	Signal fault, Smart trim gap sensor	210	Overpressure	244	Fault, On/Off/Auto switch
178	Signal fault, vibration sensor	211	Underpressure	245	Pump continuous runtime too long
179	Signal fault, bearing temperature sensor (Pt100), general or top bearing	212	Diaphragm tank precharge pressure out of range	246	User-defined relay has been forced (manually operated/commanded)
180	Signal fault, bearing temperature sensor (Pt100), middle bearing	213	VFD not ready	247	Power-on notice (device/system has been switched off)
181	Signal fault, PTC sensor (short-circuited)	214	Water shortage, level 2	248	Fault, battery/UPS
182	Signal fault, bearing temperature sensor (Pt100), bottom bearing	215	Soft pressure build-up timeout		

12. BACnet MAC address

BACnet address	SW6	SW7
0	0	0
1	0	1
2	0	2
3	0	3
4	0	4
5	0	5
6	0	6
7	0	7
8	0	8
9	0	9
10	0	A
11	0	B
12	0	C
13	0	D
14	0	E
15	0	F
16	1	0
17	1	1
18	1	2
19	1	3
20	1	4
21	1	5
22	1	6
23	1	7
24	1	8
25	1	9
26	1	A
27	1	B
28	1	C
29	1	D
30	1	E
31	1	F
32	2	0
33	2	1
34	2	2
35	2	3
36	2	4
37	2	5
38	2	6
39	2	7
40	2	8
41	2	9
42	2	A
43	2	B
44	2	C
45	2	D
46	2	E
47	2	F
48	3	0
49	3	1
50	3	2
51	3	3
52	3	4
53	3	5
54	3	6
55	3	7
56	3	8
57	3	9
58	3	A
59	3	B
60	3	C
61	3	D
62	3	E
63	3	F
64	4	0
65	4	1
66	4	2
67	4	3
68	4	4
69	4	5
70	4	6
71	4	7
72	4	8
73	4	9
74	4	A
75	4	B
76	4	C
77	4	D
78	4	E
79	4	F
80	5	0
81	5	1
82	5	2
83	5	3
84	5	4
85	5	5
86	5	6
87	5	7
88	5	8
89	5	9
90	5	A
91	5	B
92	5	C
93	5	D
94	5	E
95	5	F
96	6	0
97	6	1
98	6	2
99	6	3
100	6	4
101	6	5
102	6	6
103	6	7
104	6	8
105	6	9
106	6	A
107	6	B
108	6	C
109	6	D
110	6	E
111	6	F
112	7	0
113	7	1
114	7	2
115	7	3
116	7	4
117	7	5
118	7	6
119	7	7
120	7	8
121	7	9
122	7	A
123	7	B
124	7	C
125	7	D
126	7	E
127	7	F

If the MAC address switches are set to an invalid MAC address value, a MAC address of 0 will be used.

Argentina
Bombas GRUNDFOS de Argentina S.A.
Ruta Panamericana km. 37.500 Lote 34A
1619 - Garin
Pcia. de Buenos Aires
Phone: +54-3327 414 444
Telefax: +54-3327 411 111

Australia
GRUNDFOS Pumps Pty. Ltd.
P.O. Box 2040
Regency Park
South Australia 5942
Phone: +61-8-8461-4611
Telefax: +61-8-8340 0155

Austria
GRUNDFOS Pumpen Vertrieb Ges.m.b.H.
Grundfosstraße 2
A-5082 Grödig/Salzburg
Tel.: +43-6246-883-0
Telefax: +43-6246-883-30

Belgium
N.V. GRUNDFOS Bellux S.A.
Boomsesteenweg 81-83
B-2630 Aartselaar
Tél.: +32-3-870 7300
Télécopie: +32-3-870 7301

Belorussia
Представительство ГРУНДФОС в Минске
220123, Минск,
ул. В. Хоружей, 22, оф. 1105
Тел.: +(37517) 233 97 65,
Факс: +(37517) 233 97 69
E-mail: grundfos_minsk@mail.ru

Bosnia/Herzegovina
GRUNDFOS Sarajevo
Trg Heroja 16,
BiH-71000 Sarajevo
Phone: +387 33 713 290
Telefax: +387 33 659 079
e-mail: grundfos@bih.net.ba

Brazil
Mark GRUNDFOS Ltda.
Av. Humberto de Alencar Castelo Branco, 630
CEP 09850 - 300
São Bernardo do Campo - SP
Phone: +55-11 4393 5533
Telefax: +55-11 4343 5015

Bulgaria
GRUNDFOS Pumpen Vertrieb
Representative Office - Bulgaria
Bulgaria, 1421 Sofia
Lozenetz District
105-107 Arsenalski blvd.
Phone: +359 2963 3820, 2963 5653
Telefax: +359 2963 1305

Canada
GRUNDFOS Canada Inc.
2941 Brighton Road
Oakville, Ontario
L6H 6C9
Phone: +1-905 829 9533
Telefax: +1-905 829 9512

China
GRUNDFOS Pumps (Shanghai) Co. Ltd.
51 Floor, Raffles City
No. 268 Xi Zang Road. (M)
Shanghai 200001
PRC
Phone: +86-021-612 252 22
Telefax: +86-021-612 253 33

Croatia
GRUNDFOS CROATIA d.o.o.
Cebini 37, Buzin
HR-10010 Zagreb
Phone: +385 1 6595 400
Telefax: +385 1 6595 499
www.grundfos.hr

Czech Republic
GRUNDFOS s.r.o.
Čajkovského 21
779 00 Olomouc
Phone: +420-585-716 111
Telefax: +420-585-716 299

Denmark
GRUNDFOS DK A/S
Martin Bachs Vej 3
DK-8850 Bjerringbro
Tlf.: +45-87 50 50 50
Telefax: +45-87 50 51 51
E-mail: info_GDK@grundfos.com
www.grundfos.com/DK

Estonia
GRUNDFOS Pumps Eesti OÜ
Peterburi tee 92G
11415 Tallinn
Tel: + 372 606 1690
Fax: + 372 606 1691

Finland
OY GRUNDFOS Pumput AB
Mestarintie 11
FIN-01730 Vantaa
Phone: +358-3066 5650
Telefax: +358-3066 56550

France
Pompes GRUNDFOS Distribution S.A.
Parc d'Activités de Chesnes
57, rue de Malacombe
F-38290 St. Quentin Fallavier (Lyon)
Tél.: +33-4 74 82 15 15
Télécopie: +33-4 74 94 10 51

Germany
GRUNDFOS GMBH
Schlüterstr. 33
40699 Erkrath
Tel.: +49-(0) 211 929 69-0
Telefax: +49-(0) 211 929 69-3799
e-mail: infoservice@grundfos.de
Service in Deutschland:
e-mail: kundendienst@grundfos.de

Greece
GRUNDFOS Hellas A.E.B.E.
20th km. Athinon-Markopoulou Av.
P.O. Box 71
GR-19002 Peania
Phone: +0030-210-66 83 400
Telefax: +0030-210-66 46 273

Hong Kong
GRUNDFOS Pumps (Hong Kong) Ltd.
Unit 1, Ground floor
Siu Wai Industrial Centre
29-33 Wing Hong Street &
68 King Lam Street, Cheung Sha Wan
Kowloon
Phone: +852-27861706 / 27861741
Telefax: +852-27858664

Hungary
GRUNDFOS Hungária Kft.
Park u. 8
H-2045 Törökbálint,
Phone: +36-23 511 110
Telefax: +36-23 511 111

India
GRUNDFOS Pumps India Private Limited
118 Old Mahabalipuram Road
Thoraipakkam
Chennai 600 096
Phone: +91-44 2496 6800

Indonesia
PT GRUNDFOS Pompa
Jl. Rawa Sumur III, Blok III / CC-1
Kawasan Industri, Pulogadung
Jakarta 13930
Phone: +62-21-460 6909
Telefax: +62-21-460 6910 / 460 6901

Ireland
GRUNDFOS (Ireland) Ltd.
Unit A, Merrywell Business Park
Ballymount Road Lower
Dublin 12
Phone: +353-1-4089 800
Telefax: +353-1-4089 830

Italy
GRUNDFOS Pompe Italia S.r.l.
Via Gran Sasso 4
I-20060 Truccazzano (Milano)
Tel.: +39-02-95838112
Telefax: +39-02-95309290 / 95838461

Japan
GRUNDFOS Pumps K.K.
Gotanda Metalion Bldg., 5F,
5-21-15, Higashi-gotanda
Shiagawa-ku, Tokyo
141-0022 Japan
Phone: +81 35 448 1391
Telefax: +81 35 448 9619

Korea
GRUNDFOS Pumps Korea Ltd.
6th Floor, Aju Building 679-5
Yeoksam-dong, Kangnam-ku, 135-916
Seoul, Korea
Phone: +82-2-5317 600
Telefax: +82-2-5633 725

Latvia
SIA GRUNDFOS Pumps Latvia
Deglava biznesa centrs
Augusta Deglava ielā 60, LV-1035, Rīga,
Tālr.: + 371 714 9640, 7 149 641
Fakss: + 371 914 9646

Lithuania
GRUNDFOS Pumps UAB
Smolensko g. 6
LT-03201 Vilnius
Tel: + 370 52 395 430
Fax: + 370 52 395 431

Malaysia
GRUNDFOS Pumps Sdn. Bhd.
7 Jalan Peguam U1/25
Glenmarie Industrial Park
40150 Shah Alam
Selangor
Phone: +60-3-5569 2922
Telefax: +60-3-5569 2866

México
Bombas GRUNDFOS de México S.A. de C.V.
Boulevard TLC No. 15
Parque Industrial Stiva Aeropuerto
Apodaca, N.L. 66600
Phone: +52-81-8144 4000
Telefax: +52-81-8144 4010

Netherlands
GRUNDFOS Netherlands
Veluwezoom 35
1326 AE Almere
Postbus 22015
1302 CA ALMERE
Tel.: +31-88-478 6336
Telefax: +31-88-478 6332
e-mail: info_gnl@grundfos.com

New Zealand
GRUNDFOS Pumps NZ Ltd.
17 Beatrice Tinsley Crescent
North Harbour Industrial Estate
Albany, Auckland
Phone: +64-9-415 3240
Telefax: +64-9-415 3250

Norway
GRUNDFOS Pumper A/S
Strømsveien 344
Postboks 235, Leirdal
N-1011 Oslo
Tlf.: +47-22 90 47 00
Telefax: +47-22 32 21 50

Poland
GRUNDFOS Pompy Sp. z o.o.
ul. Klonowa 23
Baranowo k. Poznania
PL-62-081 Przeźmierowo
Tel: (+48-61) 650 13 00
Fax: (+48-61) 650 13 50

Portugal
Bombas GRUNDFOS Portugal, S.A.
Rua Calvet de Magalhães, 241
Apartado 1079
P-2770-153 Paço de Arcos
Tel.: +351-21-440 76 00
Telefax: +351-21-440 76 90

România
GRUNDFOS Pompe România SRL
Bd. Biruintei, nr 103
Pantelimon county Ilfov
Phone: +40 21 200 4100
Telefax: +40 21 200 4101
E-mail: romania@grundfos.ro

Russia
ООО Грундфос
Россия, 109544 Москва, ул. Школьная 39
Тел. (+7) 495 737 30 00, 564 88 00
Факс (+7) 495 737 75 36, 564 88 11
E-mail grundfos.moscow@grundfos.com

Serbia
GRUNDFOS Predstavništvo Beograd
Dr. Milutina Ivkovića 2a/29
YU-11000 Beograd
Phone: +381 11 26 47 877 / 11 26 47 496
Telefax: +381 11 26 48 340

Singapore
GRUNDFOS (Singapore) Pte. Ltd.
24 Tuas West Road
Jurong Town
Singapore 638381
Phone: +65-6865 1222
Telefax: +65-6861 8402

Slovenia
GRUNDFOS PUMPEN VERTRIEB Ges.m.b.H.,
Podružnica Ljubljana
Šlandrova 8b, SI-1231 Ljubljana-Črnuče
Phone: +386 1 568 0610
Telefax: +386 1 568 0619
E-mail: slovenia@grundfos.si

Spain
Bombas GRUNDFOS España S.A.
Camino de la Fuentecilla, s/n
E-28110 Algete (Madrid)
Tel.: +34-91-848 8800
Telefax: +34-91-628 0465

Sweden
GRUNDFOS AB
Box 333 (Lunnagårdsgatan 6)
431 24 Mölndal
Tel.: +46(0)771-32 23 00
Telefax: +46(0)31-331 94 60

Switzerland
GRUNDFOS Pumpen AG
Bruggacherstrasse 10
CH-8117 Fällanden/ZH
Tel.: +41-1-806 8111
Telefax: +41-1-806 8115

Taiwan
GRUNDFOS Pumps (Taiwan) Ltd.
7 Floor, 219 Min-Chuan Road
Taichung, Taiwan, R.O.C.
Phone: +886-4-2305 0868
Telefax: +886-4-2305 0878

Thailand
GRUNDFOS (Thailand) Ltd.
92 Chaloem Phrakiat Rama 9 Road,
Dokmai, Pravej, Bangkok 10250
Phone: +66-2-725 8999
Telefax: +66-2-725 8998

Turkey
GRUNDFOS POMPA San. ve Tic. Ltd. Sti.
Gebze Organize Sanayi Bölgesi
Ihsan dede Caddesi,
2. yol 200. Sokak No. 204
41490 Gebze/ Kocaeli
Phone: +90 - 262-679 7979
Telefax: +90 - 262-679 7905
E-mail: satis@grundfos.com

Ukraine
ТОВ ГРУНДФОС УКРАЇНА
01010 Київ, Вул. Московська 8б,
Тел.:(+38 044) 390 40 50
Фах.: (+38 044) 390 40 59
E-mail: ukraine@grundfos.com

United Arab Emirates
GRUNDFOS Gulf Distribution
P.O. Box 16768
Jebel Ali Free Zone
Dubai
Phone: +971-4- 8815 166
Telefax: +971-4-8815 136

United Kingdom
GRUNDFOS Pumps Ltd.
Grovebury Road
Leighton Buzzard/Beds. LU7 8TL
Phone: +44-1525-850000
Telefax: +44-1525-850011

U.S.A.
GRUNDFOS Pumps Corporation
17100 West 118th Terrace
Olathe, Kansas 66061
Phone: +1-913-227-3400
Telefax: +1-913-227-3500

Usbekistan
Представительство ГРУНДФОС в Ташкенте
700000 Ташкент ул.Усмана Носира 1-й тупик 5
Телефон: (3712) 55-68-15
Факс: (3712) 53-36-35

97572671 1209 GB

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